MAASTRICHTIAN ARENACEOUS FORAMINIFERA FROM NORTH-WESTERN NIGERIA

by S. W. PETTERS

ABSTRACT. The Dukamaje Formation in north-western Nigeria was deposited in and around a shallow embayment of the Tethys Sea which existed in the south-central Saharan region during the Middle and Late Maastrichtian. An entirely arenaceous foraminiferal assemblage occurs in the lower and upper shales of the Dukamaje Formation, while the middle marl band contains both calcareous and arenaceous species. Thirteen new arenaceous foraminiferal species are described, namely: *Haplophragmoides hausa*, *H. nigeriense*, *H. sahariense*, *H. saheliense*, *H. talokaense*, *Miliammina inflata*, *M. tsogaensis*, *Textularia dukamajina*, *T. fulani*, *T. gidankukaensis*, *T. gilbedina*, *T. rimaensis*, and *Trochammina dutsuna*.

MARINE Maastrichtian and Paleocene strata, which outcrop in north-western Nigeria (text-fig. 1), mark the south-eastern limits of a major West African intracontinental basin, the Iullemmeden Basin. This basin was occupied by an embayment of the Tethys Sea during Maastrichtian and Paleocene times (text-fig. 2). Whereas the foraminiferal microfaunas of the Paleocene deposits of the Iullemmeden Basin belong to the Tethyan palaeobiogeographic province (Berggren 1974; Petters 1978*a*) the Maastrichtian microfaunas are endemic. The dissimilarity between the Maastrichtian microfaunas of north-western and southern Nigeria, and the pinch-out of marine Maastrichtian beds north-east of Sokoto (text-fig. 1) led to the conclusion that the Maastrichtian Tethyan embayment did not extend southward beyond north-western Nigeria (Petters, 1977; in press). The endemism of the Maastrichtian microfaunas of north-western Nigeria resulted from the restricted marine environments that prevailed in the region (Petters, 1978*b*).

The marine formations in north-western Nigeria are thin and laterally persistent. They are well exposed as a result of badlands erosion in the Sahel sub-Saharan climatic belt. The Dukamaje Formation constitutes the Maastrichtian marine unit and is about 10 m thick in outcrop (text-fig. 3). It occurs between two coastal plain sandstones, the Taloka and Wurno Formations (text-fig. 4). The Dukamaje Formation comprises a lower gypsiferous, fissile, grey shale of 3 to 4 m thickness, a middle fossiliferous marl band of about 4 m, and an upper gypsiferous, fissile, grey shale of 2 to 3 m thickness.

The Dukamaje Formation is richly fossiliferous. It contains vertebrates (Swinton 1930; Halstead 1974), the ammonite *Lybicoceras*, pelecypods, and many foraminifera, ostracods, and calcareous nannoplankton. The foraminiferal microfaunas of the lower and upper shales of the Dukamaje Formation are entirely arenaceous while the marl band contains a mixture of calcareous and arenaceous taxa. The foraminiferal species *Guembelitria cretacea* Cushman, and *Orbignyna inflata* (Reuss) support Middle to Late Maastrichtian age for the Dukamaje Formation (Petters 1978*a*, *b*). Most of

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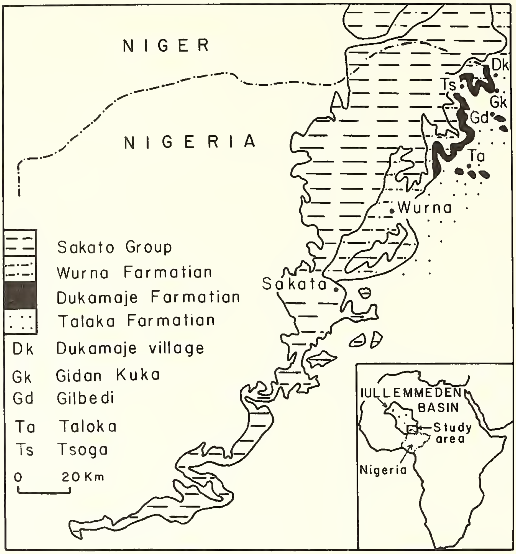
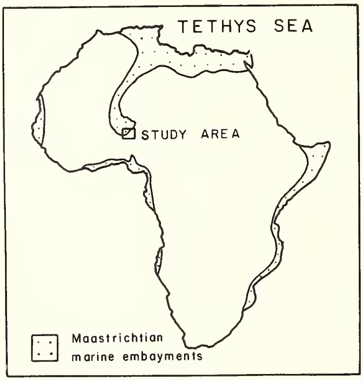


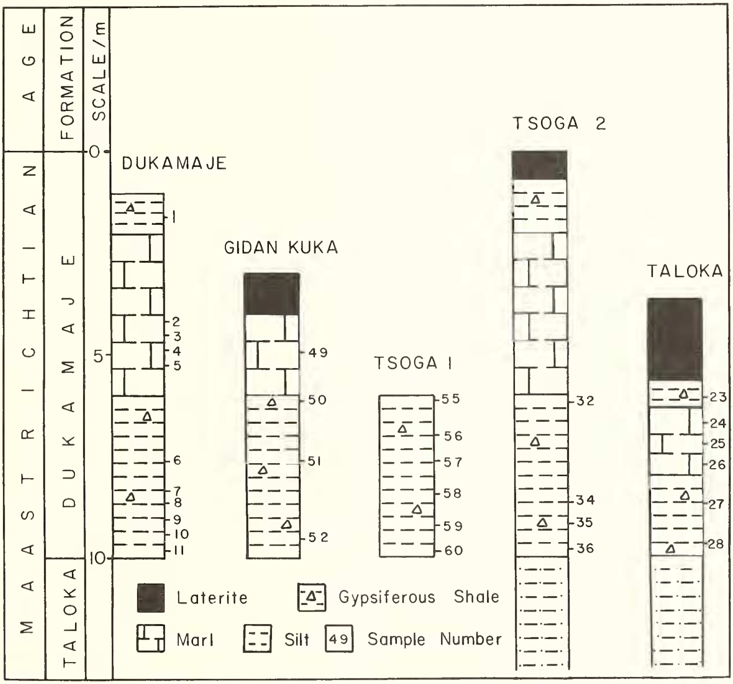
TEXT-FIG. 1. Geological sketch map of north-western Nigeria showing Maastrichtian localities.



TEXT-FIG. 2. Maastrichtian palaeogeographical sketch map of the western Sahara.

the foraminifera in the Dukamaje Formation, especially the arenaceous taxa, are new. In this article only the arenaceous species are described because of their abundance and fair preservation. The materials studied were collected from surface sections near five villages: at Dukamaje, Gidan Kuka, Taloka, and Tsoga (text-fig. 3). There are two localities near Tsoga which are here designated Tsoga 1, and Tsoga 2. At Tsoga 1, 4 m of the lower shale of the Dukamaje Formation is exposed on a hillside, while at Tsoga 2 the entire formation is exposed on a low escarpment.

Petters (1978*b*) inferred hypersaline marginal environments such as marshes and lagoons for the lower and upper shales of the Dukamaje Formation. This was based on the occurrence of thin gypsum beds, and arenaceous foraminiferal genera such as *Miliammina*, *Haplophragmoides*, *Textularia*, *Trochammina*, and *Ammobaculites*. However, in modern environments these arenaceous genera are common in both hypersaline and hyposaline marginal environments (Murray 1971). The basal 30 cm of the



TEXT-FIG. 3. Lithological logs and sample locations.

lower shale of the Dukamaje Formation is not gypsiferous in places, and shows dominance of *Miliammina*, and *Trochammina*, thus suggesting hyposaline environments. Since modern hypersaline nearshore foraminiferal assemblages contain calcareous benthonic species, in addition to simple arenaceous foraminifera (Murray 1971), the possibility of diagenetic dissolution of calcareous foraminifera from the gypsiferous shales of the Dukamaje Formation was mentioned by Petters (1978*b*).

Computed alpha-diversity values for the Dukamaje benthonic foraminiferal assemblages are generally less than 1. This falls within the alpha-diversity range of values of less than 1 to 6 for recent marshes and lagoons (Murray 1971). Using the morphogroup method of palaeoenvironmental interpretation of arenaceous foraminiferal assemblages (Chamney 1976), it was found that the Maastrichtian arenaceous assemblages of north-western Nigeria belong principally to the stable morphogroups. Thus, there is a preponderance of *Miliammina*, involute *Haplophragmoides*, *Trochammina*, and *Ammobaculites* in the Dukamaje Formation. According to the morphogroup model, such an arenaceous association was adapted to stress and marginal environments such as marshes, lagoons, estuaries, and epeiric seas. The presence of these environments in south-eastern Iullemmeden Basin is further supported by the occurrence in the Dukamaje Formation of gypsum beds, septarian nodules, crocodiles, fresh-water fishes, and calcareous nannoplankton of restricted marine origin.

Repository. The holotypes have been deposited in the University of Ife Museum of Natural History and assigned catalogue numbers (prefixed UIFNM).

SYSTEMATIC PALAEONTOLOGY

Suborder TEXTULARIINA Delage and Herouard, 1896
Superfamily LITUOLACEA de Blainville, 1825
Family RZEHAKINIDAE Cushman, 1933
Genus MALIAMMINA Heron-Allen and Earland, 1930

Miliammina inflata sp. nov.

Plate 125, fig. 6, text-fig. 5

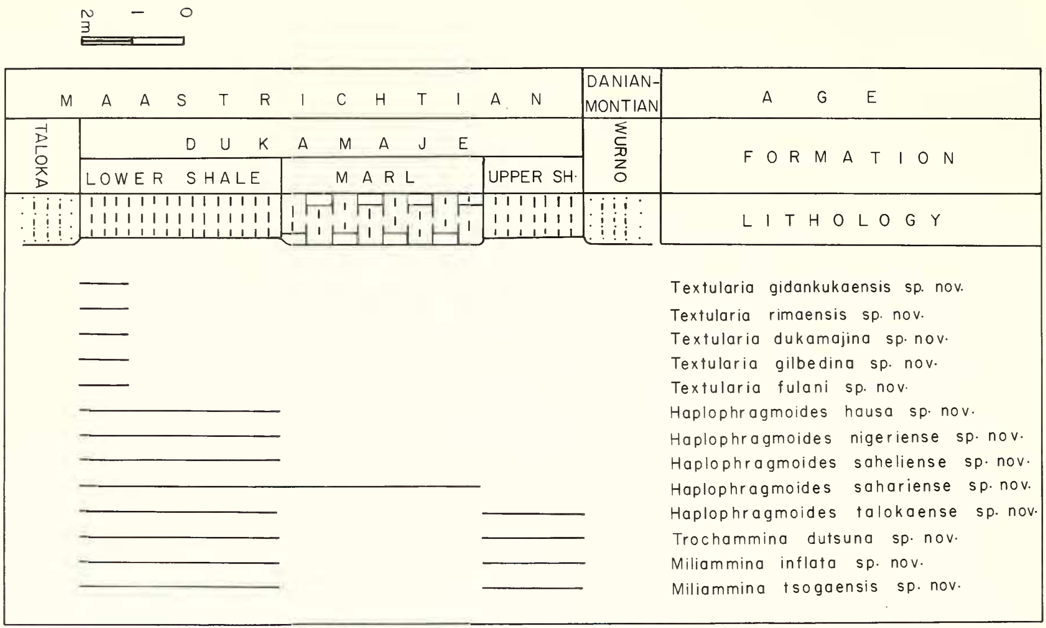
Holotype. UIFNM. P11, length 0·17 mm; width 0·13 mm, from Tsoga 1, lower shale, sample 60.

Material. Fifty paratypes from one sample. Common in the lower shale of the Dukamaje Formation and rare in the upper shale.

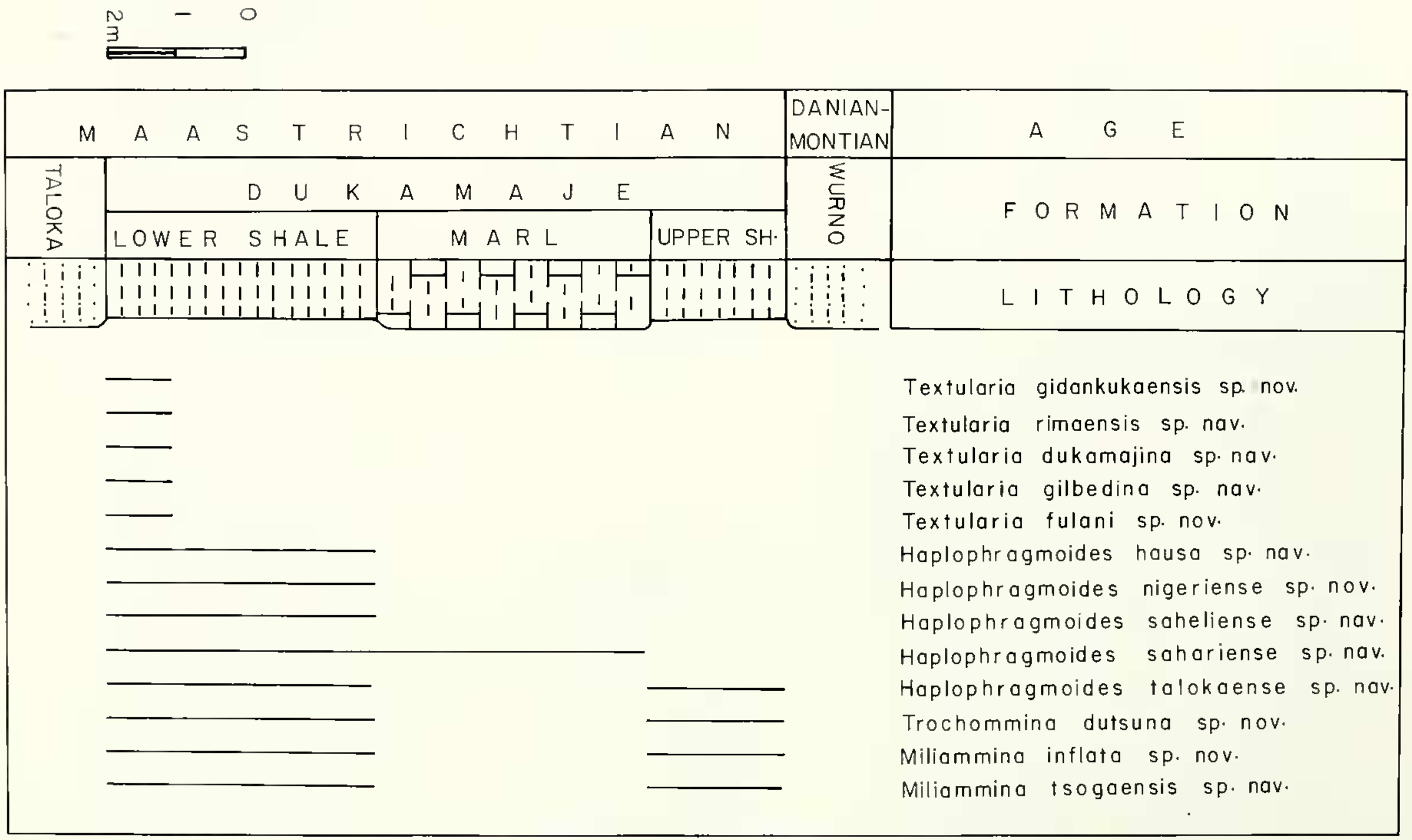
Diagnosis. Test small, quinqueloculine, inflated, with an ovate outline. Chambers with rounded periphery. The wall is rough due to the wide range of sizes of arenaceous grains and little cement.

Description. Test small, ovate and inflated. Chambers with rounded periphery. Wall composed of small discrete quartz grains of various sizes; there is little cement. The test is noncalcareous. Aperture wide and rounded.

Remarks. *Miliammina inflata* is easily distinguished from the co-occurring species *M. tsogaensis* sp. nov. because of its small, ovate, and inflated test. A few specimens of *M. inflata* are pointed at both ends. *M. manitobensis* Wickenden 1932, figured by Cushman (1946) from the Upper Cretaceous of Canada is somewhat similar to



TEXT-FIG. 4. Stratigraphical distribution of arenaceous foraminifera in the Dukamaje Formation.



TEXT-FIG. 4. Stratigraphical distribution of arenaceous foraminifera in the Dukamaje Formation.

M. inflata because both species are inflated. However, the aperture of *M. manitobensis* is located on a short neck. There is much more cement in the wall of *M. manitobensis*. *M. inflata* is also similar to *M. awunensis* Tappan, 1957, from the Upper Cretaceous of Alaska, but the test of *M. inflata* is more inflated.

Miliammina tsogaensis sp. nov.

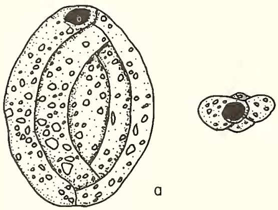
Plate 125, fig. 7; text-fig. 6

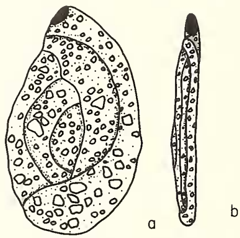
Holotype. UIFNM. P12, length 0·29 mm; width 0·15 mm, from Tsoga 1, lower shale, sample 60.

Material. Twenty-five paratypes from one sample. Common in the lower and upper shales of the Dukamaje Formation.

Diagnosis. Broad quinqueloculine test, somewhat elliptical, compressed, with slightly overlapping chambers; rounded aperture.

Description. Test elongate, subelliptical, broad, compressed. The chambers are distinct, increasing in width, and tending to overlap. Sutures distinct but poorly preserved. Wall smooth under low magnification, composed of fine quartz grains with little cement; noncalcareous. Aperture wide and rounded.





TEXT-FIG. 5 (left). *Miliammina inflata* sp. nov., holotype UIFNM. P11, (*a*) side view, (*b*) apertural view, ×460.

TEXT-FIG. 6 (right). *Miliammina tsogaensis* sp. nov., holotype UIFNM. P12, (*a*) side view, (*b*) edge view, ×250.

Remarks. *M. tsogaensis* does not exhibit much morphologic variation. However, some specimens are more elliptical and more compressed than others. This species closely resembles *Silicosigmoilina sp.* Morris, 1971, in test outline and compression, and in having an ovate aperture, and a finely arenaceous wall. Morris (1971) remarked that his specimens from the Late Cretaceous Mancos Shale of the U.S. Western Interior, may actually belong to *Miliammina*, and not to *Silicosigmoilina*. *M. tsogaensis* also resembles *M. ischnia* Tappan, 1957, also figured by Eicher (1966), from the U.S. Western Interior, but differs in being more compressed.

Family LITUOLIDAE de Blainville, 1825
Subfamily HAPLOPHRAGMOIDINAE Maync, 1952
Genus HAPLOPHRAGMOIDES Cushman, 1910

Haplophragmoides hausa sp. nov.

Plate 125, figs. 12, 13; text-fig. 7

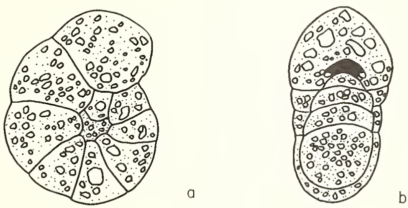
Holotype. UIFNM. P14, diameter 0·27 mm; thickness 0·09 mm, from Tsoga 1, lower shale, sample 59.

Derivation of name. After the Hausa ethnic group of northern Nigeria.

Material. Fifty paratypes from one sample. This species is abundant in the lower shale, and rare in the marl band.

Diagnosis. A *Haplophragmoides* with small, slightly evolute test; moderately inflated; rounded outline; slightly lobulate periphery; wedge-shaped chambers; smooth wall; aperture a low equatorial arch.

Description. Test planispiral, last whorl slightly evolute. Moderately lobulate equatorial periphery, broadly rounded axial periphery which may be secondarily compressed. Chambers are slightly inflated and wedge-shaped in side view; they increased gradually in size. Eight chambers in the last whorl. Umbilicus wide and deep. Sutures straight and moderately depressed. Wall smooth because of large amount of non-calcareous cement. Aperture a low equatorial interiomarginal arch.



TEXT-FIG. 7. *Haplophragmoides hausa* sp. nov., holotype UIFNM. P14, (*a*) side view, (*b*) edge view, × 230.

Remarks. The number of chambers in the last whorl is constant, but few specimens are compressed. In shape, slightly evolute coiling, deep umbilicus, slightly depressed sutures, and the shape of the aperture, *Haplophragmoides hausa* sp. nov. is somewhat similar to *H. excavata* Cushman and Waters forma beta described by Mello (1971) from the Campanian-Maastrichtian of the Pierre Shale in Wyoming. Mello figured and described several morphovariants of *H. excavata* Cushman and Waters, 1927, and included forms with slightly inflated tests. *H. hausa* sp. nov. is different from the *H. excavata* group in having a constant number of chambers, smaller size, a more inflated test, and a smooth wall.

Haplophragmoides nigeriense sp. nov.

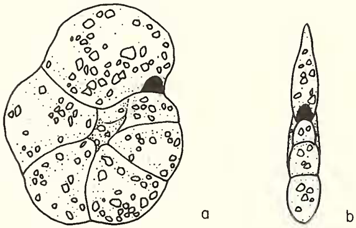
Plate 125, fig. 9; text-fig. 8

Holotype. UIFNM. P15, diameter 0·21 mm, thickness 0·04 mm, from Tsoga 1, lower shale, sample 60.

Material. Five paratypes from one sample. Rare in the lower shale and marl band.

Diagnosis. A compressed, planispirally involute, and flaring test; lobulate periphery; broad wedge-shaped and excavated chambers; small and shallow umbilicus; coarsely finished wall.

Description. Test planispirally involute, highly compressed. Periphery of the initial part of last whorl even; later strongly lobulate because the last four chambers are loosely added; axial periphery narrow. Six to eight chambers in the last whorl; chambers broad, wedge-shaped, excavated and raised near the sutures and the umbilicus; chambers increase rapidly in size, hence the flaring test. Umbilicus small and shallow. Sutures slightly curved, depressed, overhung by raised part of chambers. Wall moderately coarse with nearly uniform size of quartz grains, and little cement; noncalcareous. Aperture arched, equatorial.



TEXT-FIG. 8. *Haplophragmoides nigeriense* sp. nov., holotype UIFNM. P15, (*a*) side view, (*b*) edge view, × 345.

Remarks. H. nigeriense is very similar to *H. excavata* Cushman and Waters, 1927, figured by Cushman (1946). Both forms are strongly compressed, and have subacute peripheries and broad excavated chambers which thicken near the sutures and umbilicus. *H. nigeriense* has fewer chambers in the last whorl, and is somewhat loosely coiled. In some specimens the initial part of the last whorl resembles *H. hausa* sp. nov. in being slightly inflated, smooth, and having a rounded periphery, whereas the last three to four chambers are higher and strongly compressed. It is likely that *H. nigeriense* arose from *H. hausa* by a faster rate of chamber size increase, and stronger compression of the last whorl.

Haplophragmoides sahariense sp. nov.

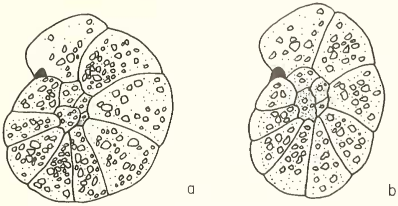
Plate 125, figs. 10, 11; text-fig. 9

Holotype. UIFNM. P16, diameter 0·27 mm; thickness 0·06 mm, from Dukamaje village, marl band at the type locality of the Dukamaje Formation, sample 2.

Material. Fourteen paratypes from one sample. This species is common in the lower shale and marl band of the Dukamaje Formation.

Diagnosis. Test circular to subcircular, compressed, last whorl evolute; slightly lobulate periphery; numerous chambers; smooth wall.

Description. Test small, planispiral, slightly evolute, moderately compressed, circular to subcircular in outline. Equatorial periphery slightly lobulate; may appear stepped because succeeding chambers start lower or higher than previous ones; axial periphery narrow, may appear truncate. Chambers narrow and elongate in equatorial plane; 9–10 in the last whorl. Umbilicus wide and shallow. Sutures distinct, slightly curved, depressed. Wall smooth; a mozaic of small, closely fitting equidimensional, angular quartz grains; noncalcareous. Aperture low interiomarginal slit.



TEXT-FIG. 9. *Haplophragmoides sahariense* sp. nov., holotype UIFNM. P16, (*a*) side view, (*b*) edge view, ×230.

Remarks. H. sahariense is easily distinguished from other species of *Haplophragmoides* in this study by its narrow and numerous chambers. Some specimens of this species are more involute than others. In test outline and coiling, number of chambers in the last whorl, and sutures, *H. sahariense* resembles *H. trinitensis* Lozo, 1944, also figured from the Cretaceous Trinity Group of Texas by Frizzell (1954). *H. sahariense* differs in having a low, arched, primary aperture.

Haplophragmoides saheliense sp. nov.

Plate 125, fig. 8., Text-fig. 10

Holotype. UIFNM. P17, diameter 0·43 mm; thickness 0·10 mm, from Tsoga 1, lower shale, sample 56.

Derivation of name. After Sahel scrubland vegetation.

Material. Six paratypes from one sample. Rare in the lower shale.

Diagnosis. Test planispiral, slightly evolute, moderately compressed; broadly indented periphery; last few chambers may be radially extended into blunt tubulospines; wall coarsely arenaceous; aperture wide and rectangular.

Description. Test moderate, planispiral, slightly evolute, moderately compressed; subcircular in outline. Periphery highly lobulate: axial periphery narrow, appears truncate. Six to seven wedge-shaped chambers in the last whorl; last few chambers are radially elongate, and may be produced into tubulospines. Umbilicus moderately wide and shallow. Sutures wide, depressed, radiate. Wall coarsely arenaceous, noncalcareous. Aperture equatorial, wide, high, and rectangular.

Remarks. This distinctive species is characterized by a strongly lobulate periphery. There is a tendency for the last few chambers to extend radially into blunt spines.

Haplophragmoides talokaense sp. nov.

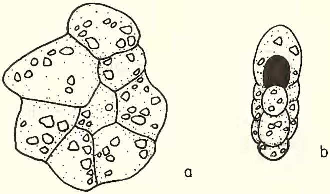
Plate 125, figs. 14, 15; text-fig. 11

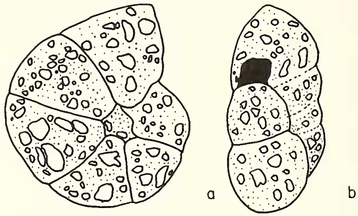
Holotype. UIFNM. P18, diameter 0·53 mm; thickness 0·19 mm, from Taloka village, upper shale of the Dukamaje Formation, sample 23.

Material. Twenty paratypes from one sample. This species is common in the lower and upper shales of the Dukamaje Formation.

Diagnosis. Test medium, planispirally involute, moderately compressed, rounded outline; open umbilicus; coarse wall texture; wide and squared equatorial aperture.

Description. Test closely coiled and planispiral. Periphery rounded; axial periphery narrow. Six to eight slightly compressed chambers in the last whorl; last chamber slightly raised. Umbilicus narrow and deep. Sutures narrow and depressed, radiate, almost obscured by coarse wall texture. Wall coarse-grained, with a large range in the sizes of the constituent quartz grains; slightly calcareous cement. Aperture equatorial, wide, and squared.





TEXT-FIG. 10 (left). *Haplophragmoides saheliense* sp. nov., holotype UIFNM. P17, (*a*) side view, (*b*) edge view, ×145.

TEXT-FIG. 11 (right). *Haplophragmoides talokaense* sp. nov., holotype UIFNM. P18, (*a*) side view, (*b*) edge view, ×130.

Remarks. This species is easily distinguished from other species of *Haplophragmoides* in this study by its coarse wall texture, rounded periphery, and the slightly raised ultimate chamber. In shape and coarse wall texture *H. talokaense* sp. nov. is similar to *H. calcula* Cushman and Waters, 1927, reported from the Upper Cretaceous of North America by Cushman (1946), and Mello (1971). However, the latter species is more strongly compressed and more coarsely arenaceous.

Family TEXTULARIIDAE Ehrenberg, 1838
Subfamily TEXTULARIINAE Ehrenberg, 1838
Genus TEXTULARIA Defrance in de Blainville, 1824

Textularia dukamajina sp. nov.

Plate 125, fig. 5; text-fig. 12

Holotype. UIFNM. P6, length 0·22 mm; width 0·11 mm, from Gidan Kuka village, base of lower shale of the Dukamaje Formation, sample 52.

Derivation of name. After Dukamaje village.

Material. Ten paratypes from one sample; common at the base of the Dukamaje Formation.

Diagnosis. Test slender, twice as long as broad, expanding uniformly; chambers elongate and slightly inflated; lobulate periphery; sutures slightly oblique in initial part of test, later sigmoid.

Description. Test biserial, small elongate and slender, compressed; periphery lobulate. Seven elongate, interlocking chambers in each row. Sutures distinct, depressed, slightly oblique in intial part of test, later sigmoid. Wall shiny, finely arenaceous, noncalcareous. Aperture a high arch at inner margin of the last chamber.

Remarks. A distinctive feature of this species is its sigmoid suture pattern. *Textularia dukamajina* does not show noticeable morphologic variation. A similar *Textularia* with a slender test, sigmoid sutures, and strongly lobulate periphery especially in the later part of the test, was figured by Israelsky (1951) as *Textularia* spp. from the Lodo Formation in California.

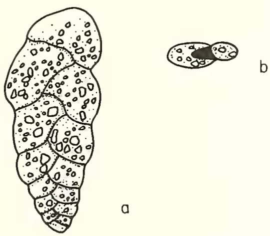
Textularia fulani sp. nov.

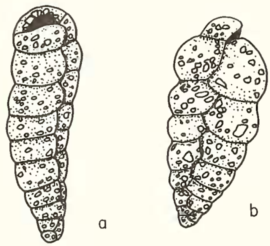
Plate 125, fig. 4; text-fig. 13

Holotype. UIFNM. P7, length 0·27 mm; width 0·08 mm, from Tsoga 2; base of lower shale, sample 35.

Derivation of name. After the Fulani ethnic group of northern Nigeria.

Material. One hundred and forty-two paratypes from one sample; very abundant at the base of the Dukamaje Formation.





TEXT-FIG. 12 (left). *Textularia dukamajina* sp. nov., holotype UIFNM. P6, (*a*) side view, (*b*) apertural view, × 340.

TEXT-FIG. 13 (right). *Textularia fulani* sp. nov., (*a*) holotype UIFNM. P7, edge view, (*b*) paratype, side view, both × 340.

Diagnosis. Test very elongate and gradually flaring, strongly compressed and easily distorted; periphery lobulate; chambers numerous and regular; sutures straight and depressed; thin and finely arenaceous wall.

Description. Test biserial, slender and very elongate, thrice as long as broad; very compressed and easily distorted such that one row of chambers may be completely pushed over and superimposed on the other. Periphery lobulate and very regular. Eight to ten chambers in a row; chambers increased gradually in size; thin and strongly compressed. Sutures distinct, depressed, and horizontal. Wall very finely arenaceous and porous; noncalcareous. Aperture wide and high arch at the base of the ultimate chamber.

Remarks. This species is characterized by a very thin and compressed test, and its strong susceptibility to distortion. Forms in which both rows of chambers lie side by side, instead of being pushed over, are rare. *T. fulani* closely resembles the Upper Cretaceous form *Textularia sp*. 1 Mello, 1971, in its narrow elongate test, numerous, closely appressed chambers which increased gradually and regularly in size, and in the horizontal and depressed sutures. Both forms are mostly flattened and distorted. They differ in the shape of the aperture, which is much wider in *T. fulani* sp. nov. In test shape, chamber arrangement, sutures, and thin, easily distorted test *T. fulani* is quite similar to the Albian form *T. topagorukensis* Tappan, 1957, described from Alaska. However, the latter form has a narrower aperture.

Textularia gidankukaensis sp. nov.

Plate 125, fig. 1; text-fig. 14

Holotype. UIFNM. P8, length 0·28 mm, width 0·16 mm, from Gidan Kuka, base of lower shale, sample 52.

Material. Twenty paratypes from one sample. This species is common at the base of the lower shale.

Diagnosis. Test biserial, flaring, compressed, pointed initial end which is often broken; greatest width at the last pair of chambers; sutures at right angles to the axis of elongation; wall smooth and shiny.

EXPLANATION OF PLATE 125

Fig. 1. *Textularia gidankukaensis* sp. nov., holotype UIFNM. P8, side view; Dukamaje Formation, lower shale, Gidan Kuka, sample 52; ×150.

Fig. 2. *T. gilbedina* sp. nov., holotype UIFNM. P9, side view; Dukamaje Formation, lower shale, Gidan Kuka, sample 52; ×100.

Fig. 3. *T. rimaensis* sp. nov., holotype UIFNM. P10, side view; Dukamaje Formation, lower shale, Gidan Kuka, sample 52; ×150.

Fig. 4. *T. fulani* sp. nov., holotype UIFNM. P7, edge view; Dukamaje Formation, lower shale, Tsoga 2, sample 35; ×150.

Fig. 5. *T. dukamajina* sp. nov., holotype UIFNM. P6, side view; Dukamaje Formation, lower shale, Gidan Kuka, sample 52; ×150.

Fig. 6. *Miliammina inflata* sp. nov., holotype UIFNM. P11, side view; Dukamaje Formation, lower shale, Tsoga 1, sample 60; ×200.

Fig. 7. *M. tsogaensis* sp. nov., holotype UIFNM. P12, side view; Dukamaje Formation, lower shale, Tsoga 1, sample 60; ×150.

Fig. 8. *Haplophragmoides saheliense* sp. nov., holotype UIFNM. P17, side view; Dukamaje Formation, lower shale, Tsoga 1, sample 56; ×65.

Fig. 9. *H. nigeriense* sp. nov., holotype UIFNM. P15, side view; Dukamaje Formation, lower shale, Tsoga 1, sample 60; ×150.

Figs. 10, 11. *H. sahariense* sp. nov., 10, holotype UIFNM. P16, side view; 11, paratype, edge view; both from Dukamaje Formation type locality, marl band, Dukamaje, sample 2; both ×100.

Figs. 12, 13. *H. hausa* sp. nov., 12, holotype UIFNM. P14, side view; ×100; 13, paratype, edge view, ×150; both from Dukamaje Formation, lower shale, Tsoga 1, sample 59.

Figs. 14, 15. *H. talokaense* sp. nov., 14, paratype, edge view, ×55; 15, holotype UIFNM. P18, side view, ×60; both from Dukamaje Formation, upper shale, sample 23.

Figs. 16, 17. *Trochammina dutsuna* sp. nov., 16, holotype UIFNM. P13, umbilical view, ×150: 17, paratype, spiral view, ×200; both from Dukamaje Formation, lower shale, Tsoga 2, sample 34.

PETTERS, Maastrichtian Foraminifera

Description. Test small, flaring, compressed; maximum width at the last pair of chambers. Periphery slightly indented. Nine to ten chambers in each row increasing rapidly in size; compressed but last pair of chambers slightly inflated. Sutures indistinct along median part of test; they are more distinct and depressed near the periphery where they coincide with peripheral indentations; sutures are slightly oblique or nearly at right angles to the axis of elongation. Wall fairly smooth with angular quartz grains of various sizes; little cement; noncalcareous. Aperture wide, high arch, nearly occupying the entire apertural face.

Remarks. This species shows little morphologic variation and is distinguished from other species of *Textularia* in this paper by its strongly flaring test, and sutures which are obscure, slightly oblique, or nearly normal to the axis of elongation. *T. gidankukaensis* is similar to *T. schwageri* LeRoy, 1953, from the Paleocene of Egypt. Both species have rapidly expanding compressed tests with maximum width near the apertural end, slightly oblique sutures, and a smooth wall. However, *T. schwageri* has a much lower aperture which is an elongate slit at the base of the last chamber. *T. ariyalurensis* Banerji, 1967, from the Upper Cretaceous of India, is somewhat similar to *T. gidankukaensis* in the flaring test and nearly horizontal sutures, but *T. ariyalurensis* has narrower chambers, and a lower ultimate chamber with a flat apertural face.

Textularia gilbedina sp. nov.

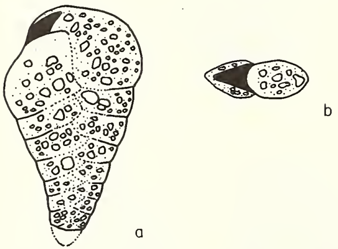
Plate 125, fig. 2; text-fig. 15

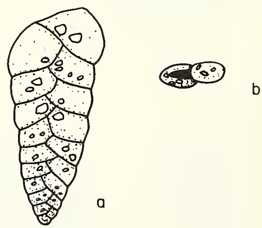
Holotype. UIFNM. P9, length 0·39 mm, width 0·16 mm, from Gidan Kuka, base of lower shale, sample 52.

Derivation of name. After Gilbedi village.

Material. Fifteen paratypes from one sample; abundant at the base of the lower shale.

Diagnosis. A narrow and elongate *Textularia* with compressed, numerous, and closely appressed chambers; straight to slightly lobulate periphery; faint and flush to slightly depressed and oblique sutures; shiny wall.





TEXT-FIG. 14 (left). *Textularia gidankukaensis* sp. nov., holotype UIFNM. P8, (*a*) side view, (*b*) apertural view, ×340.

TEXT-FIG. 15 (right). *Textularia gilbedina* sp. nov., holotype UIFNM. P9, (*a*) side view, (*b*) apertural view, ×210.

Description. Test biserial, narrow, elongate, compressed. Periphery smooth and straight in the initial part of the test; later slightly lobulate. Nine to twelve closely appressed chambers in each row; chambers increased gradually in size. Sutures indistinct in early part of test, oblique and slightly depressed in the later part of the test. Wall shiny and polished, with abundant noncalcareous cement. Aperture high and narrow slit.

Remarks. This species is characterized by its narrow, elongate, and smooth test. It varies in the number of chambers in the test. *T. washitensis* Carsey, 1926, is similar to *T. gilbedina* in having a narrow, elongate, smoothly finished test with much cement. However, *T. washitensis* Carsey figured by Tappan (1940) and by Frizzell (1954), differs in that it has limbate and less oblique sutures.

Textularia rimaensis sp. nov.

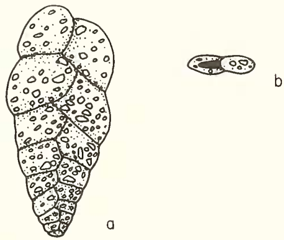
Plate 125, fig. 3; text-fig. 16

Holotype. UIFNM. P10, length 0·25 mm, width 0·18 mm, from Gidan Kuka, base of lower shale, sample 52.

Derivation of name. After a major nearby river, the Rima.

Material. Thirty-five paratypes from one sample, abundant at the base of the lower shale.

Diagnosis. Test elongate, slightly flaring; broadly lobulate periphery; chambers narrow and compressed in early part of test, later broad, high, and slightly inflated; sutures initially almost normal to the axis of elongation, later strongly oblique.



TEXT-FIG. 16. *Textularia rimaensis* sp. nov., holotype UIFNM. P10, (*a*) side view, (*b*) apertural view, ×350.

Description. Test biserial, small, expanding fairly rapidly, flaring; periphery strongly lobulate especially in the later half of the test. Eight to nine chambers in each row; chambers in the initial part of the test are narrow and appressed; later they are broad and loosely touching. Sutures distinct, depressed and oblique in later half of the test. Wall smooth, with fine quartz grains; noncalcareous. Aperture a narrow slit.

Remarks. The last two pairs of chambers are usually slightly inflated. The broadly lobulate periphery and strongly oblique sutures in the later part of the test characterize this species. *T. rimaensis* is similar to *T. dukamajina* sp. nov. in the shape of the test. However, *T. rimaensis* has a slightly wider test, and the sutures are not sigmoid. *T. rimaensis* sp. nov. exhibits little morphologic variation.